

Multiwavelength study of the transient X-ray binary IGR J01583+6713

Ramanpreet Kaur ^{1*}, Biswajit Paul ², Brijesh Kumar ^{1,3}, Ram Sagar ¹

¹ *Aryabhata Research Institute of observational sciencES (ARIES), Manora Peak, Naini Tal, 263 129, India*

² *Raman Research Institute, C.V. Raman Avenue, Sadashivanagar, Bangalore 560 080, India*

³ *Departamento de Física, Universidad de Concepción, Casilla 160-C, Concepción, Chile*

ABSTRACT

We have investigated multiband optical photometric variability and stability of the H α line profile of the transient X-ray binary IGR J01583+6713. We set an upper limit of 0.05 mag on photometric variations in the *V* band over a time scale of 3 months. The H α line is found to consist of non-Gaussian profile and quite stable for a duration of 2 months. We have identified the spectral type of the companion star to be B2 IVe while distance to the source is estimated to be ~ 4.0 kpc. Along with the optical observations, we have also carried out analysis of X-ray data from three short observations of the source, two with the *Swift*-XRT and one with the *RXTE*-PCA. We have detected a variation in the absorption column density, from a value of 22.0×10^{22} cm⁻² immediately after the outburst down to 2.6×10^{22} cm⁻² four months afterwards. In the quiescent state, the X-ray absorption is consistent with the optical reddening measurement of $E(B - V) = 1.46$ mag. From one of the *Swift* observations, during which the X-ray intensity was higher, we have a possible pulse detection with a period of 469.2 s. For a Be X-ray binary, this indicates an orbital period in the range of 216–561 days for this binary system.

Key words: stars: individual: IGR J01583+6713 – binaries: general – stars: pulsars: general – stars: emission-line, Be – X-rays: stars

* E-mail: raman@aries.ernet.in

1 INTRODUCTION

The ESA X-ray and γ -ray observatory *INTEGRAL* has discovered more than 100 sources during its continuous monitoring of the sky, especially in the direction of the Galactic Center and its surroundings, since its launch in 2002. Many of the X-ray sources discovered by *INTEGRAL* are characterized by a hard X-ray spectrum, with little or no detectable emission in soft X-rays, since they are heavily absorbed by interposing material. X-ray characteristics of most of these sources indicate them to be High Mass X-ray Binaries (HMXBs) and in many cases this has been proved by the discovery of their optical counterparts (e.g. Masetti et al. 2006a, Negueruela et al. 2007).

The X-ray transient IGR J01583+6713 was discovered by the IBIS/ISGRI imager on board *INTEGRAL* during an observation of the Cas A region on Dec 6, 2005 (Steiner et al. 2005). The source was detected with a mean flux of about 14 mCrab in the 20-40 keV band, while a null detection was reported in the higher energy band of 40-80 keV. In subsequent *INTEGRAL* observations of the same field during Dec. 8-10, 2005, the X-ray flux was found to be decreasing on a timescale of days. *Swift* observations of the source on December 13, 2005 identified IGR J01583+6713 to be a point object located at RA : 01^h 58^m 18^s.2 and DEC: +67° 13' 25".9 (J2000) with an uncertainty of 3.5 arc seconds and its spectral analysis revealed that it is highly absorbed with N_H approximately 10^{23} cm⁻² as compared to the estimated galactic value of $N_H = 4.7 \times 10^{21}$ cm⁻² towards the same direction (Kennea et al. 2005). Follow-up optical and IR observations identified the X-ray source as a Be star with magnitudes - B=14.98, R=13.24 and I=12.12, displaying strong H α (EW 70 Å) and weak H β (EW 6 Å) lines in emission and it was therefore proposed as the optical/IR counterpart of the X-ray source (Halpern et al. 2005). Recently, based on low resolution single epoch optical spectroscopy on December 23, 2006, Masetti et al. (2006b) classified the counterpart as an early spectral type (O8 III or O9 V) Galactic (~ 6.4 kpc) star and ruled out both the possibility of a supergiant companion and of the source being an LMXBs or CVs.

In this paper, we present results of new optical (photometric and spectroscopic) observation of the Be system over an extended period and analyze all the X-ray data on IGR J01583+6713 present in the HEASARC archive. Section 2 and 3 present the observations and data reduction. Section 4 deals with the results and discussions on the nature of the companion star, possible variability and characterization of the X-ray spectrum. We summarize the results in the last section.

2 OPTICAL OBSERVATIONS

The broadband photometric and intermediate resolution spectroscopic optical observations are described in the following sections.

2.1 *UBVRI* Photometry

We have carried out broadband Johnson *UBV* and Cousins *RI* CCD photometric follow-up observations on 13 nights from December 13, 2005 to March 06, 2006 using a $2k \times 2k$ CCD camera mounted at f/13 Cassegrain focus of the 104-cm Sampurnanand Telescope (ST) at ARIES, Nainital, India. At the focus, a $24 \mu\text{m}$ square pixel of the 2048×2048 size CCD chip corresponds to ~ 0.36 arcsec and the entire chip covers a square area of side ~ 13.0 arcmin on the sky. The read-out noise of the system is 5.3 electrons with a gain factor of 10 electrons per analog-to-digital unit (ADU). During our observations the seeing varied from about 1.2 to 2.4 arcsec. Table 1 lists the log of optical photometric observations of IGR J01583+6713 in *UBVRI* wavebands along with the number of frames taken and exposure time in the respective filters. Usually more than two exposures were taken in each filter with a typical exposure times of 300 s, 300 s, 300 s, 200 s and 150 s in the *UBVRI* wave-bands respectively. Bias frames were taken intermittently and flat-field exposures were made of the twilight sky. In addition, as part of other ongoing programs, we could secure observations of Landolt (1992) standard fields in *UBVRI* wavebands on four nights (see Table 1) near zenith and the same field was also observed at about five different zenith distances for extinction measurements.

Figure 1 shows the field chart of IGR J01583+6713 observed with ST on December 13, 2006 in the *B* waveband. Although all the observations were taken with the entire CCD chip of 13×13 arcmin, we have shown only a 7.5×7.5 arcmin CCD frame in Figure 1 for a closer look at the field. For photometric comparison we selected six stars with similar brightness and these are marked as 1, 2, 3, 4, 5 and 6 in Figure 1 while ‘T’ denotes the X-ray transient IGR J01583+6713.

Photometric data reductions were performed using the standard routines in IRAF¹ and DAOPHOT (Stetson 1987). The zero-points and color terms were applied in the usual manner (Stetson 1992). The standard magnitudes of all six stars were found to be stable on all four nights and were treated as local standards. Their mean standard magnitudes are listed

¹ IRAF is distributed by National Optical Astronomy Observatories, USA

in Table 2. The mean magnitudes and colors for IGR J01583+6713 are estimated as $V = 14.43 \pm 0.03$, $U - B = 0.09 \pm 0.04$, $B - V = 1.22 \pm 0.07$, $V - R = 0.99 \pm 0.03$, $V - I = 1.88 \pm 0.05$. The difference in the measured (B_{obs} , V_{obs} , R_{obs} and I_{obs}) and standard (B_{st} , V_{st} , R_{st} and I_{st}) $BVRI$ magnitudes of IGR J01583+6713 and comparison star 1 are plotted in Figure 2. The variation was observed to be consistent with the typical photometric uncertainty with standard deviations of 0.01 mag for BVR and 0.02 mag for the I passband for comparison star 1. For IGR J01583+6713 an increase in flux of about 0.05 mag is apparent around 13 Dec 2005, followed by a constant flux level thereafter.

2.2 Spectroscopy

Spectroscopic observations of IGR J01583+6713 were made on eight nights during August 18, 2006 to October 28, 2006 using the Himalayan Faint Object Spectrograph and Camera (HFOSC) available with the 2-m Himalayan Chandra Telescope (HCT), located at Hanle, India. The pixel size of the CCD used is $15\mu\text{m}$ with an image scale of $0.297\text{ arcsec pixel}^{-1}$. The log of observations with the respective exposure times is given in Table 3. We have used a slit of dimensions $1.92'' \times 11'$ for the $\text{H}\alpha$ line profile study and a slit of dimensions $15.41'' \times 11'$ for the calibration observations. The spectrum were obtained with two different gratings (Grism 7 & Grism 8) in the wavelength range of $3500\text{--}7000\text{ \AA}$ and $5800\text{--}8350\text{ \AA}$ at a spectral dispersion of $1.45\text{ \AA pixel}^{-1}$ and $1.25\text{ \AA pixel}^{-1}$ respectively. Data were reduced using the standard routines within IRAF. The data were bias-corrected, flat-fielded and the one dimensional spectrum extracted using the optimal extraction method (Horne 1986). The wavelength calibration was done using FeAr and FeNe lamp spectrum for the Grism 7 and Grism 8 spectrum respectively. We employed the IRAF task *identify* and typically around 18 emission lines of Fe, Ar and Ne were used to find a dispersion solution. A fifth order fit was used to achieve a typical RMS uncertainty of about 0.1 \AA . For flux calibration of the IGR J01583+6713 spectrum in both Grism 7 and Grism 8, the instrumental response curves were obtained using spectrophotometric standards (Hiltner 600, Feige 110) observed on the same night, and the star's spectrum were brought to the relative flux scale. $\text{H}\alpha$ is detected with a FWHM of $\sim 11.3\text{ \AA}$ for all the spectrum taken with Grism 8 of HCT.

The combined flux calibrated spectrum of X-ray binary IGR J01583+6713, taken with Grism 7 and Grism 8 on October 15, 2006 is shown in Figure 3 over a wavelength range of $3800\text{--}9000\text{ \AA}$. The identified spectral features are marked in the spectrum. The blue region

of Grism 7, in the wavelength region 3600–3800 Å has poor Signal-to-Noise ratio and is not shown in Figure 3. Along with strong H α and H β , we also detected a few weak spectral features, mainly singly ionized Iron, neutral Helium and neutral Oxygen lines, in the IGR J01583+6713 continuum spectrum in the wavelength region 6100–7900 Å, shown in Figure 4.

3 X-RAY OBSERVATIONS

The X-ray observations of IGR J01583+6713 were carried out with the X-ray Telescope (XRT) onboard the *Swift* satellite and with the Proportional Counter Array (PCA) onboard the *RXTE* satellite.

Swift carried out observations of IGR J01583+6713 on December 13, 2005 for 47 ks and on April 11, 2006 for 37 ks. Both the XRT observations had useful exposures of ~ 8 ks. The standard data pipeline package (XRTPIPELINE v. 0.10.3) was used to produce screened event files. Only data acquired in the Photon counting (PC) mode were analyzed adopting the standard grade filtering (0–12 for PC) according to XRT nomenclature. X-ray events from within a circular region of radius 0.8 arcmin, centered at the X-ray transient, were extracted for timing and spectral analysis. Background data were extracted from a neighbouring source free circular region of the same radius as taken for the source. Source and background lightcurves were generated using the X-ray counts from the respective circular regions with the instrumental time resolution of 2.5074 s. A final source lightcurve was produced by subtracting the background lightcurve. The observations were made for small segments and no variability beyond statistical variation is seen in the X-ray light curves between the segments. The final source spectrum were obtained by subtracting the background spectrum, and spectral analysis was done using the energy response of the detector for the same day.

RXTE pointed observations were performed on December 14, 2005 with a total effective exposure time of ~ 3 ks. The *RXTE*–PCA standard 2 data with a time resolution of 16 s were used to extract the spectrum of the source in the energy range 3–20 keV. During this observation only two PCUs were operational. The background spectrum for this observation was generated using the task ‘pcabackest’. PCA background models for faint sources were used to generate the background spectrum. The spectral response matrix of the detector was created using the task ‘pcarsp’ and applied for spectral fitting. The spectrum was rebinned to have sufficient signal to noise ratio in each bin of the spectrum. The source was also regularly

monitored by the All Sky Monitor (ASM) on board *RXTE*. The ASM lightcurve is shown in Figure 5 from MJD 53660 to MJD 54160, including the outburst detected on MJD 53710. The epoch of detection of the hard X-ray transient IGR J01583+6713 is marked as ‘T’ in the Figure 5. The soft X-ray enhancement in the *RXTE*–ASM light curve is consistent with a 10–20 mCrab intensity. The optical and X-ray observations of IGR J01583+6713 taken for the present study are also marked in Figure 5.

We have used XSPEC12 for X-ray spectral analysis. We fitted both a powerlaw model and a black-body model with line of sight absorption to the source spectrum obtained from *Swift* and *RXTE*. The spectral parameters obtained for both the models for the three observations are given in Table 4. Both the powerlaw and black-body models fit the data well with a reduced χ^2 in the range of 0.8–1.4, except for the *RXTE* spectrum which is not well fitted by a black-body model. Models are indistinguishable from spectral fit only. Figure 6 shows the powerlaw fit to the *Swift* observations made on December 13, 2005 (top panel), *RXTE* observations made on December 14, 2005 (middle panel), and *Swift* data taken on April 05, 2006 (bottom panel).

The *Swift* spectrum for both the observations made on December 13, 2005 and April 05, 2006 have coarse energy binning, making the Iron emission line at 6.4 keV undetectable in the raw spectrum. To find the upper limit on the 6.4 keV emission line in the *Swift* spectrum taken on December 13, 2005, we fixed the line-center energy at 6.4 keV in the spectrum and fitted a Gaussian to the line. The upper limit on the equivalent width of the 6.4 keV emission line is determined to be 100 eV with 90% confidence limit.

We searched for X-ray Pulse periods using a pulse-folding technique. The background count rate was subtracted from the IGR J01583+6713 lightcurve and the barycenter correction was done. The time resolution of the instrument and the time span of the continuous data constrained the pulse period search to the range 5s - 800s. We found X-ray pulsations with a pulse period of 469.2 s and with a pulsed fraction of 22%. Figure 7 shows the light curve of IGR J01583+6713, observed with *Swift* on December 13, 2005, folded with the pulse period of 469.2 s. However the evidence of pulsation detection is marginal with a false-alarm-probability of 10^{-4} .

4 RESULTS AND DISCUSSIONS

4.1 Photometric Variability

There were 7 photometric observations made in 15 days from December 13, 2005 to December 28, 2005 and later on there were observations with a gap of 20–25 days for the next 3 months. No variability of more than 2 sigma is found in any pass-band but a larger variation and decreasing trend is seen for the first few days of observations in all of the pass-bands, as shown in Figure 2. The scatter in data points of IGR J01583+6713 is more than the comparisons stars by ~ 2 sigma in all the pass-bands and some increase in magnitude of about 0.05 mag can be seen around MJD 53725. The decrease in reprocessed optical emission for few days of outburst does indicate that source flux was decreasing during that period. However, we claim no strong variability in this source and we cannot ascertain whether the source was brighter in the optical band during the peak of its X-ray outburst.

4.2 Stability of the $H\alpha$ emission line

The dynamical evolution of Be envelope can be studied with the help of changes in emission line profile (Negueruela et al. 2001). Table 3 shows the spectroscopic observations of IGR J01583+6713 made over a period of 2 months. Strong $H\alpha$ and $H\beta$ emission line features are always found in the spectrum with equivalent width of $-74.5 \pm 1.6 \text{ \AA}$ and $-5.6 \pm 0.3 \text{ \AA}$ respectively. This ratio is somewhat different from that reported by Masetti et al (2006b), which may indicate structural changes in the circumstellar disk of Be star in this system.

The line equivalent width and line profile of the $H\alpha$ line are found to be constant for the observations, listed in Table 3. The resolution of our instrument was not good enough to carry out a detailed study of the $H\alpha$ line shape. The $H\alpha$ line gives a poor fit with a Gaussian model, leaving the wings of the line unfitted. However, the $H\alpha$ line, being very strong, of equivalent width -75 \AA , confirms that it originated in the circumstellar disk.

4.3 X-ray variability and Spectrum

X-ray observations of IGR J01583+6713 were made on December 13, 2005 by *Swift* after the detection of its outburst on December 6, 2005 by *INTEGRAL*. The pulsations at 469.2 seconds were detected with a pulsed fraction of 22%. Corresponding to 469.2 sec pulse period, we have estimated the X-ray binary IGR J01583+6713 orbital period in the range

216–561 days (Corbet 1986) assuming the maximum eccentricity of the orbit to be 0.47 for Be binaries as observed by Bildsten et al. (1997).

Figure 6 (top) and (bottom) show the powerlaw fitting to the *Swift* observations made on December 13, 2005 and April 05, 2006. N_H is found to decrease from $22.0 \times 10^{22} \text{ cm}^{-2}$ to $2.6 \times 10^{22} \text{ cm}^{-2}$ for the two *Swift* observations of IGR J01583+6713, using the powerlaw model. Using the blackbody model, N_H is found to decrease from $15.2 \times 10^{22} \text{ cm}^{-2}$ to $0.5 \times 10^{22} \text{ cm}^{-2}$. Photon index and black-body temperature are in the range 1.7–2.0 and 1.3–1.8 keV respectively, for all the observations listed in Table 4. *Swift* observations clearly show that N_H has decreased by about an order of magnitude in a span of four months. The observed flux in 2-10 keV band has also decreased by a factor of ~ 4 . Within measurement uncertainty, the power-law photon index (or the black-body temperature in the blackbody emission model) is found to be unchanged.

Lack of variability in the optical photometric measurements indicate an absence of changes in the distribution of circumstellar material around the companion star. However, from the X-ray spectral measurements we have detected a significant change in the absorption column density. During the first *Swift* observations, when the source was brighter, we measured an absorption column density of $(22 \pm 10) \times 10^{22} \text{ cm}^{-2}$ and the spectrum shows an upper limit of 100 eV on equivalent width of an iron K-fluorescence line. If we assume an isotropic distribution of absorbing matter around the compact object, where the X-ray emission originates, we expect the Fe 6.4 keV spectral line to be detected with an equivalent width of 250 eV (Makishima et al. 1986), a factor of 2.5 more than the upper limit. The absence of a strong iron emission line indicates that the X-ray absorbing material around the compact object has a non-isotropic distribution, probably related to its disk structure.

4.4 Spectral Classification

A low dispersion ($4\text{\AA}/\text{pix}$) optical (3500-8700 \AA) spectrum taken one day after the outburst was presented by Massetti et al. (2006b). However, due to the absence of any photospheric absorption feature and poor signal, they could not secure a definite classification so assuming a Galactic reddening and $(B - R)_0$ intrinsic color they assigned a spectral type of O8III or O9V. The present spectrum cover the same spectral region and have a better spectral resolution ($\sim 3 \text{\AA}$ near H_α), however, the MK classical region ($< 5000\text{\AA}$) was too weak to identify absorption features. Figure 3 shows the combined flux calibrated spectrum of IGR

J01583+6713 on October 15, 2006. The continuum normalized spectrum taken on October 15, 2006 and October 16, 2006 are shown in Figure 4. Most of the spectral features in the 3800–8800 Å region are identified and marked. We compare these features with a near infrared spectral library by Andrillat (1988 & 1990, henceforth AND90) of a sample of 70 emission line Be stars with known MK spectral type (B0–B9) at resolution (1.2 Å). We describe the spectrum as following.

Hydrogen lines are seen in emission. H_α and H_β show single peak while the Paschen lines (P12–P20) have a double-peak structure with the red (R) peak greater than the blue (V) one. CaII (8498, 8542, 8662 Å) and NI (Multiplet at 8630 Å and 8680 Å) are also in emission. In their sample, AND90 found that the HI and CaII emission features are strong in early type (< B5) stars and diminish strongly for later type stars. CaII triplet emission was associated with a large IRAS excess.

The present spectrum also show OI (8446 Å and Triplet 7773 Å) in emission which is seen in most of the cases with stars having spectral type earlier than B2.5. The features of IGR J1583+6713 resemble most closely to HD 164284 (B2 IV-Ve) in Andrillat (1988) and HD 41335 (B2 IVe) in Andrillat (1990). For a comparison, HD 164284 spectrum is shown on the top of IGR J01583+6713 spectrum in Figure 8 over a wavelength range of 7500–8800 Å.

FeII (6248, 6319, 6384, 6456, 6516, 7515 and 7711 Å) and SiII (6347 Å) lines appear in emission. He I lines at 6678 and 7281 are in absorption with asymmetric profiles indicating the presence of an emission region. Based on these characteristics it is suggested that its spectral type lies around B1 to B3, however a later spectral type cannot be completely ruled out and a further high resolution spectrum in the Optical and NIR would be required to ascertain the true spectral type for the transient. Furthermore, the weak Fe 6.4 keV line ($EW \leq 100$ eV) in the X-ray spectrum and a high hydrogen column density may suggest the presence of a wind-powered accretion disc, hence leaving the possibility of a low-luminosity blue supergiant open. However, the strong Hydrogen lines suggest that it belongs to a main sequence (IV-V) luminosity class (Leitherer 1988).

We employed the reddening free Q-parameter to further ascertain the spectral type of the star. Using the normal reddening slope, $X[E(U-B)/E(B-V)] = 0.72$, the $Q=[(U-B)-X(B-V)]$ parameter was found to be -0.63 ± 0.06 and this corresponds to a spectral type of B2-3 for an early type main-sequence star (Johnson & Morgan 1954).

We derive a color excess $E(B - V) = 1.46 \pm 0.05$ mag by adopting B2 IV as a companion and taking the intrinsic color $(B - V)_0 = -0.24$ mag (Schmidt-Kaler 1982) and a mean

observed color of 1.22 ± 0.05 mag. An estimate of reddening at other wavelengths is made following Fitzpatrick et al. (1999) and the intrinsic colors are found to be $(U - B)_0 = -1.00$, $(V - R)_0 = -0.15$ and $(V - I)_0 = -0.35$ quite consistent with intrinsic colors corresponding to a B2 IV star with $(U - B)_0 = -0.86$ (Schmidt-Kaler 1982), $(V - R)_0 = -0.10$ and $(V - I)_0 = -0.29$ (Wegner 1994). The above color excesses yield a value of visual extinction $A_V = 4.5 \pm 0.2$ mag. Using the absolute magnitude from Lang et al. (1992), and from the relation $m - M = 5 \log D - 5 + A_V$, the distance to the source is estimated to be 4.0 ± 0.4 kpc placing the transient well beyond the Perseus arm of the Milky Way.

For $A_V \sim 4.5$, the corresponding column density N_H is $\sim 8.1 \times 10^{22} \text{ cm}^{-2}$. The X-ray observations made by *Swift* during the quiescent state of the transient IGR J01583+6713 on April 05, 2006 gave N_H of the order of $0.5 \times 10^{22} \text{ cm}^{-2}$ for blackbody fit and $3 \times 10^{22} \text{ cm}^{-2}$ for the powerlaw fit. The galactic HI column density is $0.4 \times 10^{22} \text{ cm}^{-2}$ in the direction of the transient. However, the N_H obtained using the powerlaw model is closer to the N_H calculated using optical extinction measurement as compared to the blackbody model. Thus we conclude that the powerlaw model fits better to the X-ray data than the blackbody spectrum. The powerlaw index is found to be varying between 1.7–2.0, which is common in accretion powered X-ray pulsars.

5 SUMMARY

The nature of the hard X-ray transient IGR J01583+6713 and its optical counterpart has been investigated using new photometric and spectroscopic data in the optical as well as the X-ray band. Over a one year period since the X-ray outburst (December 06, 2005), UBVRI CCD photometric data were collected on 15 nights using 1-m ST optical telescope at Nainital. The intermediate resolution (3\AA at $H\alpha$) spectrum in the 3800–8800 \AA region was monitored with the 2-m HCT telescope at Hanle, India on 8 nights. In X-ray, the archival spectral and timing data from *Swift* and *RXTE* observations were analysed to probe the nature of this highly obscured X-ray source. The main conclusions of the study are as follows.

- (i) No significant variability in V-band is seen, however an upper limit of 0.05 mag is set over a time scale of 3 months since the X-ray outburst.
- (ii) The spectral characteristics of the optical counterpart were found to be consistent with a B2 IV (classical Be) star showing strong emission lines of Hydrogen (single peak Balmer and double peak Paschen), ionized Calcium, ionized Silicon, Oxygen, Nitrogen and

ionized Iron. The source is located ($l=129^\circ$, $b = 5^\circ$) well beyond the Perseus arm of the Milky Way at a heliocentric distance of $\sim 4.0 \pm 0.4$ kpc.

(iii) We derive a hydrogen column density of $22.0 \times 10^{22} \text{ cm}^{-2}$ from the X-ray spectrum taken with *Swift* just after the outburst. The quiescent phase column density was found to be consistent with the optical extinction measurements. The timing measurement suggest a pulse period of 469.2 second and an orbital period in the range of 216–561 days for this binary system.

ACKNOWLEDGMENTS

We thank the referee "Juan Fabregat" for suggestions that helped us to improve the paper. We thank Dr. Maheswar Gopinathan and Mr. Manash Samal for the useful discussions on spectroscopy. One of the authors (Ramanpreet) thanks Jessy Jose, and Kuntal Misra for their help with the photometric data reduction and Dr. Anna Watts for kindly going through the draft version of the paper. This research has made use of data obtained through the High Energy Astrophysics Science Archive Research Center Online Service, provided by the NASA/Goddard Space Flight Center.

REFERENCES

- Andrillat, Y., Jaschek, M., Jaschek, C., 1988, A&AS, 72, 129
- Andrillat, A., Jaschek, M., Jaschek, C., 1990, A&AS, 84, 11
- Bildsten, L., Chakrabarty, D. John, C. et al., 1997, ApJS, 113, 367
- Corbet, R. H. D., 1986, MNRAS, 220, 1047
- Fitzpatrick, E. L., 1999, PASP, 111, 63
- Halpern, J. P., Tyagi, S., 2005, ATel, 681
- Horne, K., 1986, PASP, 98, 609
- Johnson, H. L., Morgan, W. W., 1954, ApJ, 119, 344
- Kennea, J. A., Racusin, J. L., Burrows, D. N., et al., 2005, ATel, 673
- Landolt, A. U., 1992, AJ, 104, 340
- Leitherer, C., 1988, ApJ, 326, 356
- Lang, K. R. 1992, Astrophysical Data: Planets and Stars (New York: Springer-Verlag)
- Makishima, K. 1986, in The Physics of Accretion onto Compact Objects, ed. K. O. Mason, M. G. Watson, & N. E. White (Berlin: Springer), 249

- Masetti, N., Pretorius, M. L., Palazzi, E., et al. 2006a, *A&A*, 449, 1139
- Masetti, N., Bassani, L., Bazzano, A., et al. 2006b, *A&A*, 455, 11
- Negueruela, I., Okazaki, A. T., Fabregat, J., Coe, M. J., Munari, U., Tomov, T., 2001, *A&A*, 369, 117
- Negueruela, I., Schurch, M. P. E., *A&A*, 2007, 461, 631
- Schmidt-Kaler, Th. 1982, *Landolt-Bornstein: numerical data*, ed. K. Schaifers, & H. H. Voigt (Springer-Verlag)
- Steiner, C., Eckert, D., Mowlavi, N., et al. 2005, *ATel*, 672
- Stetson, P. B., 1987, *PASP*, 99, 191
- Stetson, P. B., 1992, *JRASC*, 86, 71
- Wegner, W., 1994, *MNRAS*, 270, 229

Table 1. Log of broadband optical photometric observations of the transient source and Landolt (1992) standard fields

Object	Date of Observation	Filter	Exposure time (seconds)
IGR J01583+6713	2005 Dec 13	V/R	2×600/2×300
	2005 Dec 17	B/V/R/I	2×300/2×300/3×200/2×150
	2005 Dec 18	B/V/R/I	3×300/3×300/3×150/3×150
	2005 Dec 19	V/R/I	1×300/1×200/1×150
	2005 Dec 20	B/V/R/I	1×300/2×300/1×300/3×150
	2005 Dec 21	R/I	1×150/2×150
	2005 Dec 28	B/V/R/I	1×300/2×300/2×200/3×150
	2006 Jan 25	B/R/I	1×300/2×200/1×150
	2006 Jan 26	B/V/R/I	1×300/2×300/2×200/2×150
	2006 Feb 24	B/V/R	2×300/2×300/2×200
	2006 Feb 28	V/R	1×300/1×200
	2006 Mar 02	U/B/V/R/I	2×300/2×300/2×300/2×200/2×150
	2006 Mar 06	B/V/R	1×300/1×300/1×200
	2006 Nov 24	U/B/V/R/I	2×300/2×300/2×300/2×200/2×150
	2006 Dec 13	U/B/V/R/I	3×300/3×300/3×300/2×200/2×150
Landolt standard field			
SA104	2006 Jan 25	B/R/I	11×300/11×60/11×60
SA101	2006 Mar 02	U/B/V/R/I	9×300/9×180/9×180/9×120/9×120
SA92	2006 Nov 24	U/B/V/R/I	2×300/2×300/2×180/2×130/2×100
SA95	2006 Nov 24	U/B/V/R/I	7×500/7×300/7×150/7×100/7×100
SA98	2006 Dec 13	U/B/V/R/I	7×450/7×300/7×120/7×60/7×60
RU149	2006 Dec 13	U/B/V/R/I	2×300/2×300/2×120/2×60/2×60

Table 2. *BVRI* magnitudes of comparison stars

Star no.	B	V	R	I
1	15.55	14.51	13.91	13.37
2	17.57	15.45	14.17	13.00
3	16.54	15.38	14.68	14.02
4	16.25	14.92	14.11	13.36
5	16.13	14.73	13.90	13.20
6	17.71	15.52	14.20	12.99

Table 3. Log of spectroscopic observations of the X-ray transient IGR J01583+6713

Date of Observation	Wavelength Range (Å)	Exposure time (seconds)
2006 Aug 18	3500-7000:5200-9200	1x900/1x900
2006 Oct 14	3500-7000:5200-9200	1x900/1x900
2006 Oct 15	3500-7000:5200-9200	1x1200/1x900
2006 Oct 16	5200-9200	1x900
2006 Oct 17	5200-9200	1x900
2006 Oct 18	3500-7000:5200-9200	1x900/1x900
2006 Oct 28	5200-9200	1x900
2006 Oct 29	5200-9200	1x600

Table 4. Spectral Parameters for *Swift* and *RXTE* observations.

	<i>RXTE</i>	<i>Swift</i>	
Spectral parameters of model (Absorption + powerlaw)			
Parameter	2005 December 14	2005 December 13	2006 April 05
N _H × 10 ²² (cm ^{−2})	< 6.0 (with 90% confidence)	21.96 ± 9.60	2.58 ± 1.06
PhoIndex	1.71 ± 0.22	1.74 ± 0.56	2.05 ± 0.60
Reduced χ ² /dof	1.4/14	0.8/19	1.1/13
Observed Flux 2-10 keV (ergs cm ^{−2} s ^{−1})	5.0e-12	11.6e-12	3.1e-12
Unabsorbed Flux 2-10 keV (ergs cm ^{−2} s ^{−1})	5.5e-12	29.7e-12	4.0e-12
Spectral parameters of model (Absorption + blackbody)			
Parameter	2005 December 14	2005 December 13	2006 April 05
N _H × 10 ²² (cm ^{−2})	< 1.5 (with 90% confidence)	15.16 ± 6.23	0.45 ± 0.22
Blackbody temperature (keV)	1.61 ± 0.44	1.81 ± 0.49	1.34 ± 0.10
Reduced χ ² /dof	2.5/14	0.8/19	1.2/13
Observed Flux 2-10keV (ergs cm ^{−2} s ^{−1})	5.1E-12	10.8E-12	3.7E-12
Unabsorbed Flux 2-10keV (ergs cm ^{−2} s ^{−1})	5.8E-12	19.6E-12	3.9E-12

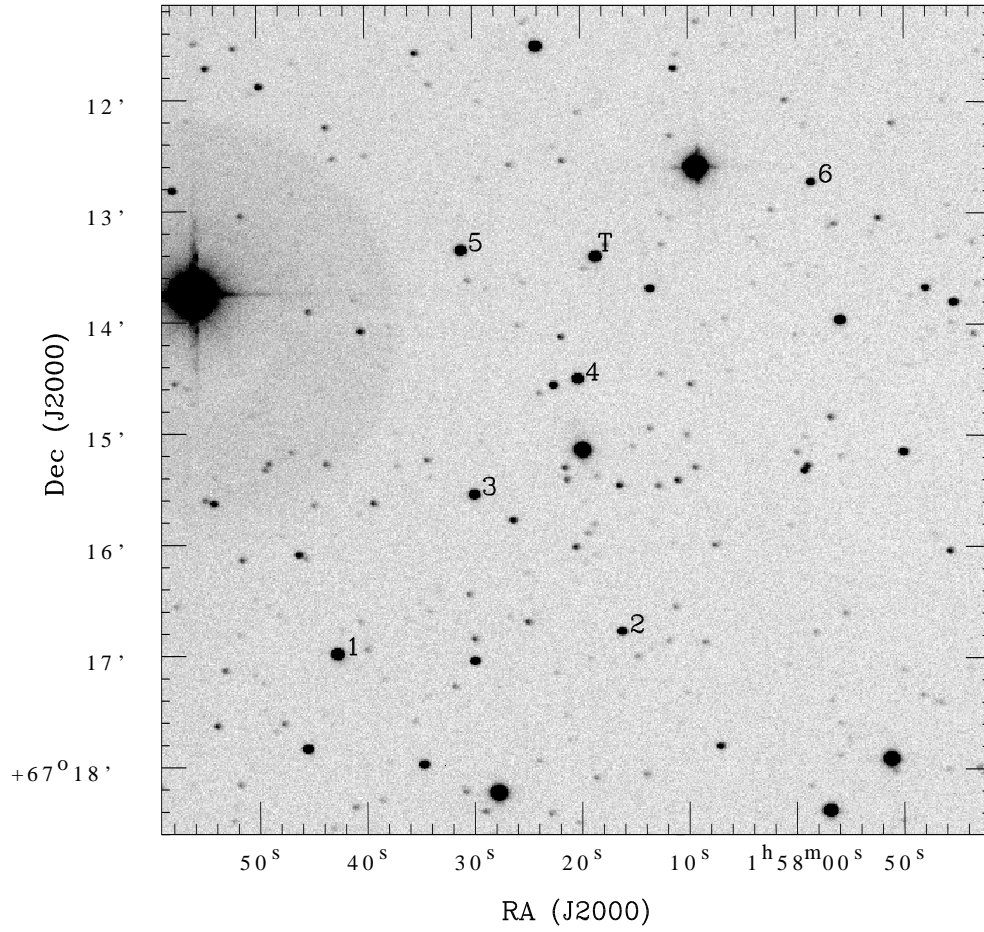


Figure 1. Identification chart of IGR J01583+6713 taken with ST in B passband on December 13, 2006. The transient is marked as 'T' and comparison stars are marked as 1, 2, 3, 4, 5 and 6 in the figure

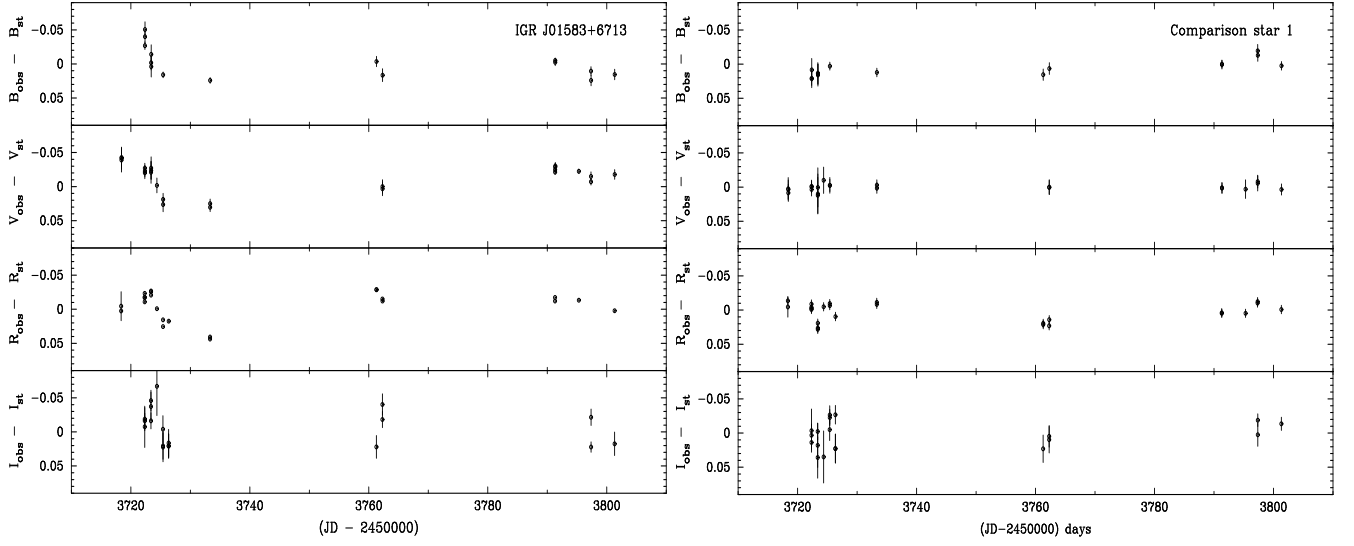


Figure 2. The difference in the measured (B_{obs} , V_{obs} , R_{obs} and I_{obs}) and standard (B_{st} , V_{st} , R_{st} and I_{st}) *BVRI* magnitudes of IGR J01583+6713 and Comparison star 1 from JD 2453710 to JD 2453810.

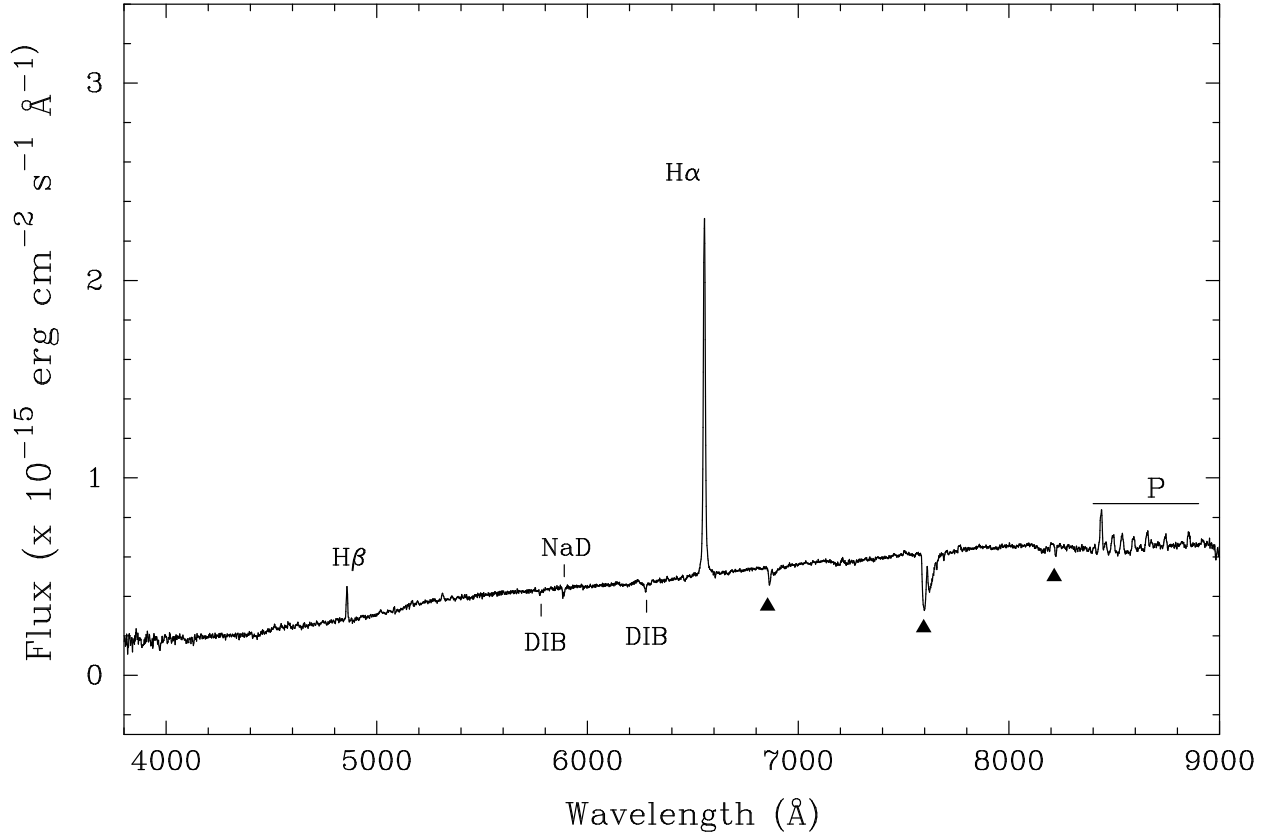


Figure 3. Flux calibrated spectrum of IGR J01583+6713 taken on October 15, 2006. Grism 7 and Grism 8 spectrum are combined together to show it over a wavelength range of 3800–9000 Å. Diffuse Interstellar bands are marked as "DIB", telluric absorption bands are marked with a filled triangle and the Sodium doublet is marked as "NaD". "P" represents Paschen lines. H α and H β are also marked.

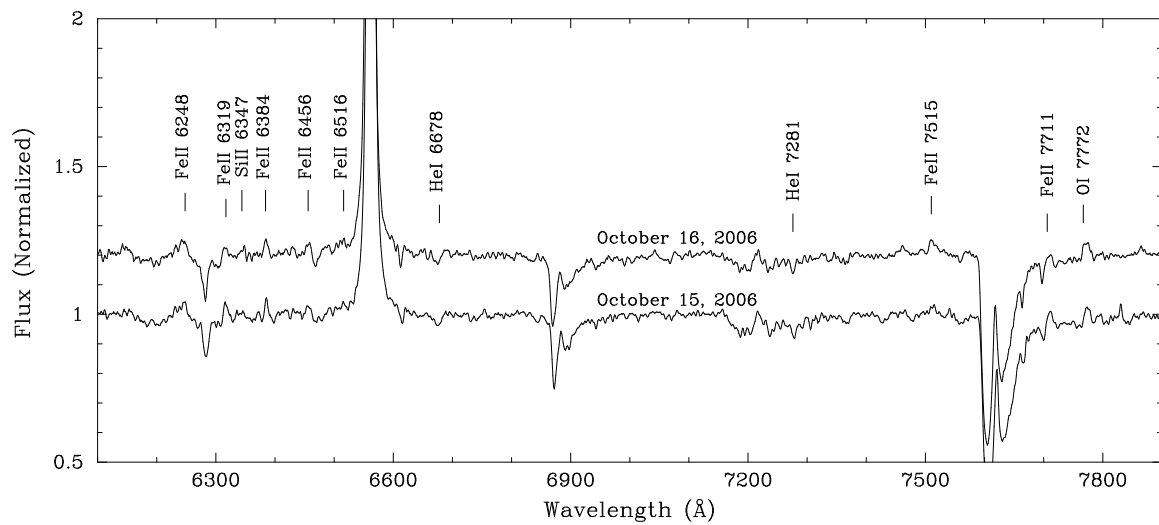


Figure 4. Continuum spectrum of IGR J01583+6713 in the wavelength range of 6100–7900 Å taken on October 15, 2006 and October 16, 2006. A few weakly identified features like FeII, HeI, SiII and OI are marked in the Figure.

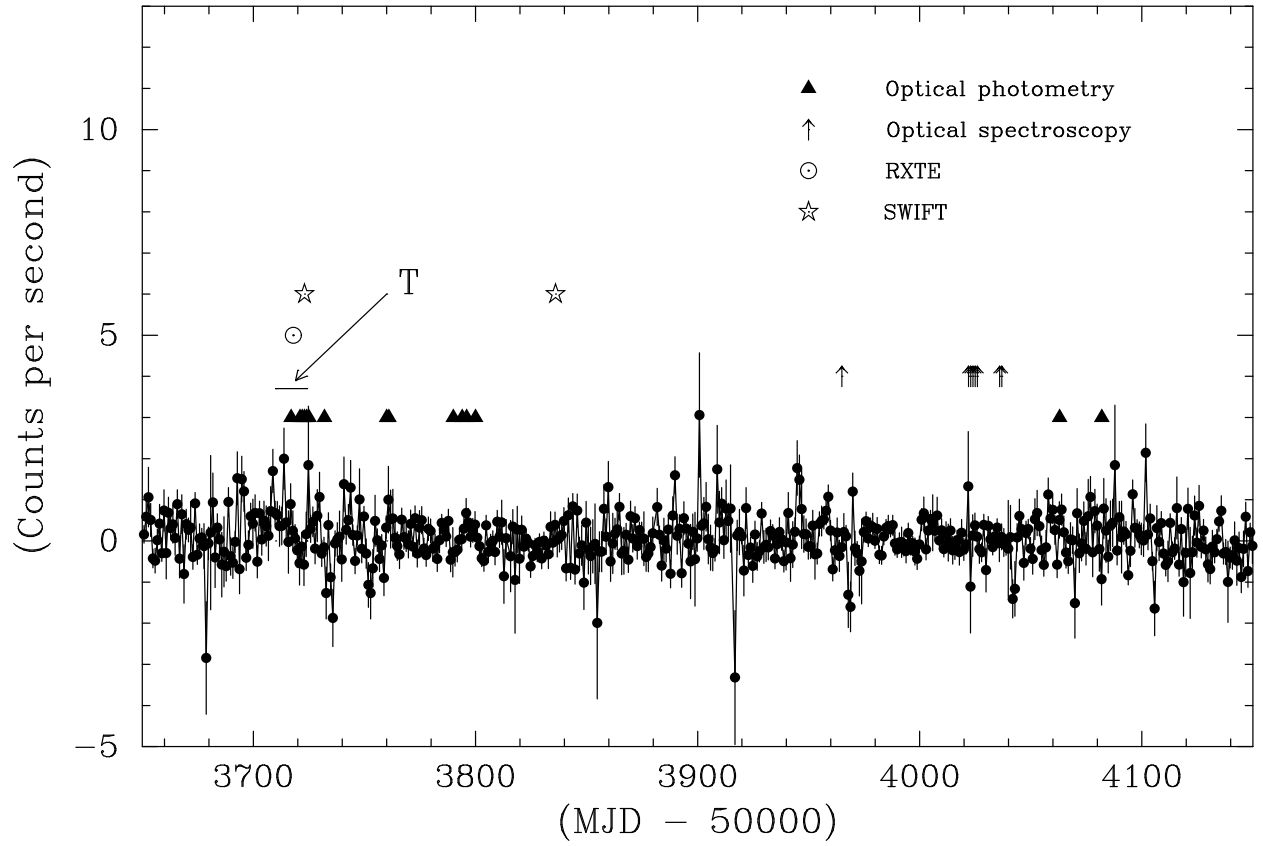


Figure 5. ASM lightcurve of IGR J01583+6713 from MJD 53660 to MJD 54160 including the outburst observed by *INTEGRAL* and *Swift* during MJD 53710 to MJD 53720, marked as "T" in the figure. Also marked are optical photometric observations (by filled triangle), optical spectroscopic observations (by up-arrow), *RXTE* observations (by open circles with a dot inside) and *Swift* observations (by open star).

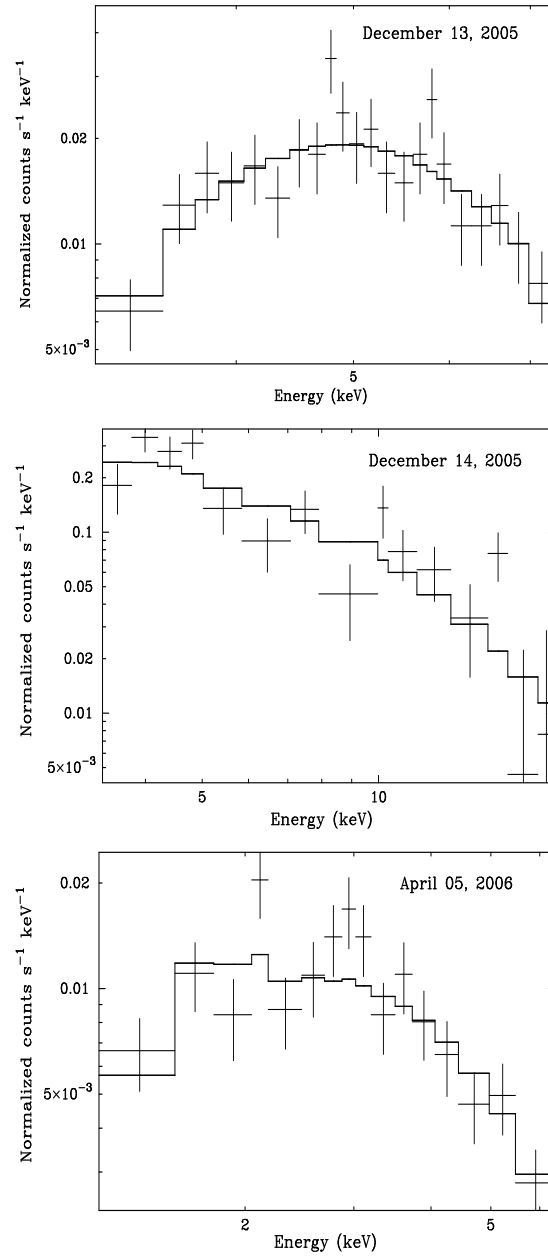


Figure 6. X-ray spectrum of IGR J01583+6713. Top - *Swift* observations made on December 13, 2005, middle - *RXTE* observations on December 14, 2005, bottom - *Swift* observations made on April 05, 2006. The points with error bars are the measured data points and the histograms are the respective best fitted model spectrum consisting of absorbed powerlaw model components, convolved with the respective telescope/detector responses.

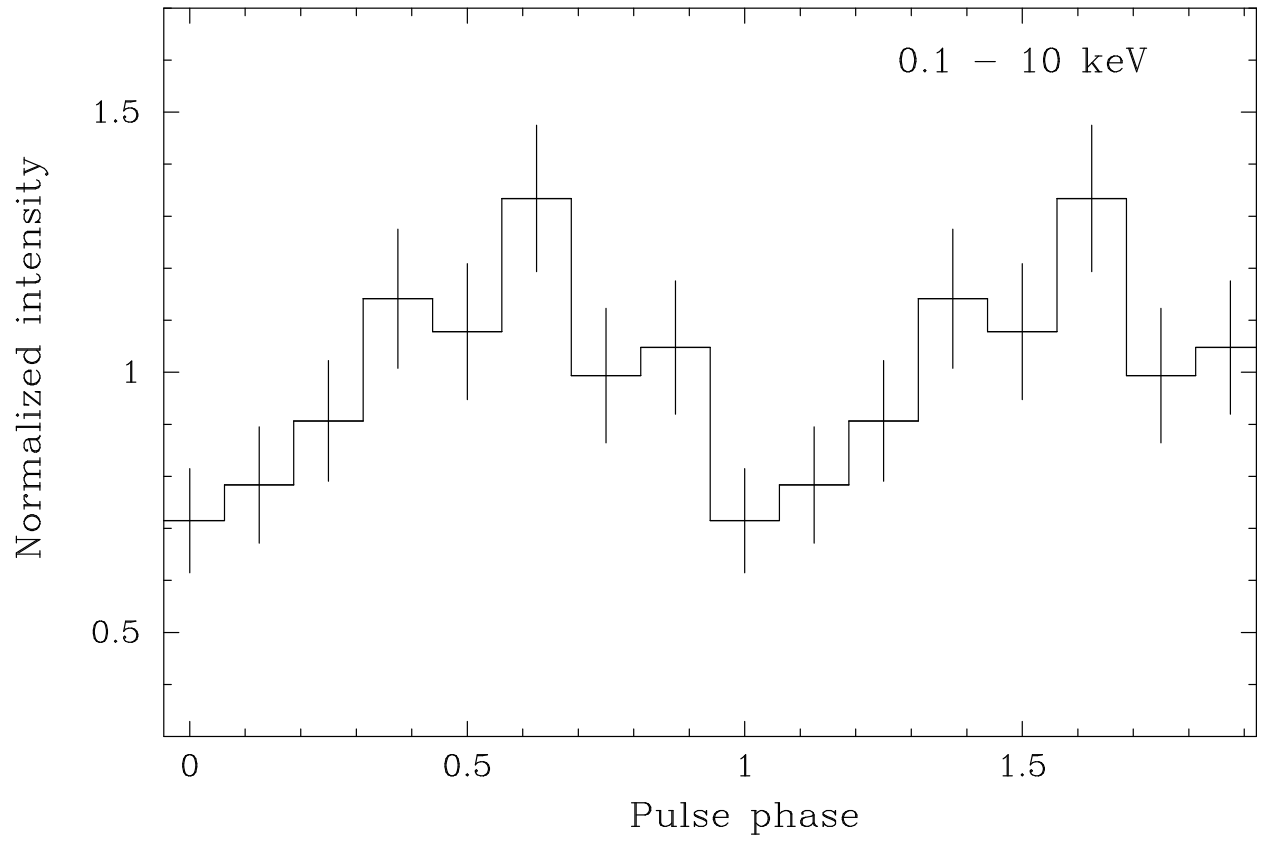


Figure 7. Light curve of IGR J01583+6713 observed by *Swift* on December 13, 2005, folded modulo 469.2 s.

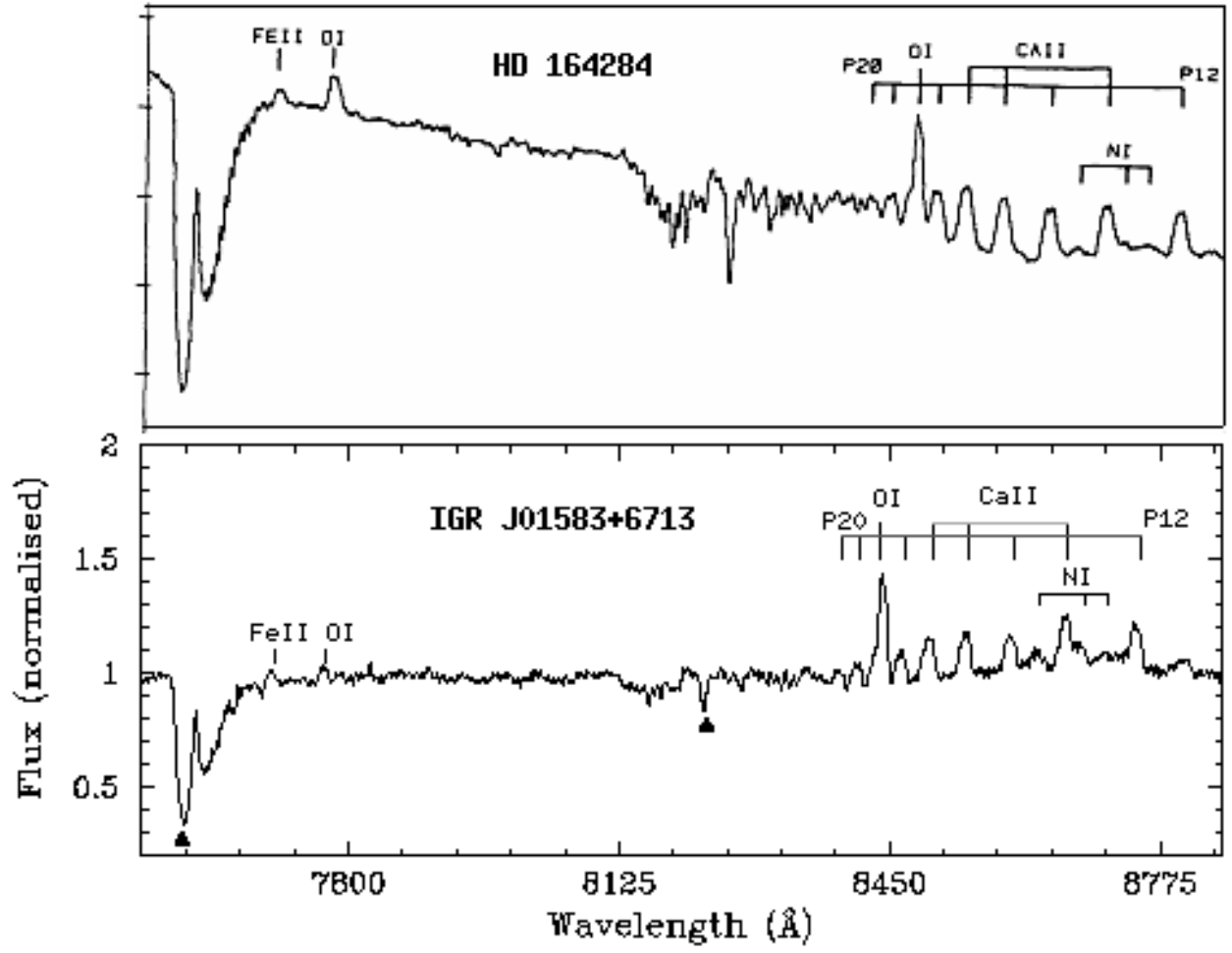


Figure 8. Bottom - Flux Normalized spectrum of IGR J01583+6713, Top - Flux calibrated spectrum of HD 164284 from Andrillat et al. (1988), a comparison. P12 to P20 are the Hydrogen Paschen lines from P12 to P20. FeII, OI, CaII and NI spectral features are also marked in the Figure.